

## Arguments for elemental targets

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In Raja's talk he had a transparency which stated:

"Why we cannot use CH<sub>2</sub>-C for getting H<sub>2</sub> data for what we need.

CH<sub>2</sub> target 1%

C=1%, H<sub>2</sub>=0.16%

1)  $\Delta H/H = 6 \cdot 1.414 \cdot \Delta CH_2/CH_2$

2) Systematic errors due to dynamics

3) Diffraction region messed up by C fragmentation

4) Loss of symmetry forward vs. backward hemisphere in pp"

(points were numbered by me).

The idea of "subtracting" targets must work at some level. The idea is that by using some compound, e.g. CH<sub>2</sub>, to measure particle and event distributions, then doing the same on a C target, that the difference of the two sets of distributions will give the H<sub>2</sub> distributions. As long as the particle interactions on the C and on the H are independent, this must be true.

The inelastic cross section for CH<sub>2</sub> is estimated in the RPP (Review of Particle Properties) to be 297 mb, and for C and H<sub>2</sub>: 231 mb and 33 mb respectively. This means that 0.78 of the inelastic events on CH<sub>2</sub> will occur on the C and 0.22 on the H<sub>2</sub>. To obtain the *same number of events* as one would with an elemental target of H<sub>2</sub> five times the events need be obtained on the CH<sub>2</sub> target, and four times on the C target. Each H<sub>2</sub> data point would require roughly 7 times the beam using the compound subtraction method. This was referred to as the "statistical argument" during the discussion at the group meeting. This is the case, I believe, that Raja is making in point 1) of his talk.

I believe that the points 2) through 4) are incorrect in the strict sense. That is, the independence of the C and H events in the compound CH<sub>2</sub> target implies that the subtracted distributions would reveal the correct H event distributions. In the analysis, the data are binned in bins of ( $M^2$ ,  $t$ ,  $s$ ) for all final states and for specific final states. To obtain the correct normalization of the data a correction must be applied to eliminate the detector/trigger bias between the C and CH<sub>2</sub> targets, bin for bin, for each of the final states studied. This could introduce a systematic uncertainty in the H distributions derived in this manner. This could be detected by comparing the acceptance corrected H distributions with those in the literature. Perhaps a monte carlo study could be used to estimate the scale of systematic error introduced in this way.

In the "diffractive region" the distributions in each of the variables  $M^2$ ,  $t$ ,  $s$  are well known. In general the effects of having a nucleus rather than a nucleon give an overall scaling taken to be something like  $A^{2/3}$ ,  $A^{0.77}$ ,  $A^1$  or most generally,  $A^\alpha$ . The uncertainty

in the nuclear scaling of the target behavior introduces some uncertainty in the detailed analysis of the data. Note that understanding this dependence is a part of the E907 physics program. What is known empirically is that:

$$\frac{dN}{dM^2} \propto \frac{1}{M^2}$$

$$\frac{dN}{dt} \propto \prod_i e^{b_i t}$$

$$\frac{dN}{ds} \propto A^\alpha s^{1/4}$$

where the t-distribution constants  $b_i$  depend on the effective size of the coherent scattering centers, often estimated as:

$$b_i \approx \left( \frac{\hbar c}{r_i} \right)^2.$$

In each of these cases the overall distribution normalization will be scaled by the effective atomic number of the target. The distributions are not altered by the nature of the target. For C it could be roughly from 5 to 10 times that for H, depending on the scaling law used. Practically speaking, this might result in the need for a larger data sample to extract sensible results using the compound target with subtraction.

A sample of C and H events using various projectiles can be subjected to the detector simulation, selected based on trigger, and analyzed to estimate the difficulty in obtaining statistically sensible results, as well as anticipating normalization problems due to finite acceptance and resolution.

Finally, if one of the goals of the experiment is to provide to the community a set of events which are interactions on H (or D, O, N), the subtraction method cannot obtain a clean sample without extensive selection in the data set (if at all).